A PARTIAL REVISION OF THE PUPÆ OF THE UNITED STATES.

BY HENRY A. PILSBRY AND EDWARD G. VANATTA.

In the present communication we have endeavored to express the morphology of the "teeth" or protective armature guarding the apertures of these minute land snails, in a terminology of the structures involved based upon their homologies, and applicable to Pupæ the world over. The remainder of the paper deals with such particular genera and species of the United States as require elucidation, and concludes with a list of the species of our fauna, with a brief statement of their distribution.

Our Pupæ were first systematically studied by Dr. Augustus A. Gould, who published his results in a well-considered monograph, in 1840–43.[1] In 1867,[2] Prof. E. S. Morse did some excellent work on the group, particularly on the species of New England. Mr. W. G. Binney, in his successive works of 1869, 1878, 1885 and 1892, included the species of our fauna then known. Finally, in 1888, Dr. Victor Sterki published the first of a long series of studies upon American Pupidæ,[3] which have marked a great advance in our knowledge of the group, not alone in an increased number of species, but in the more just appreciation of their interrelationships.

Terminology of the "Teeth" of Pupæ.

As is well known, most of the folds or teeth in the apertures of *Pupa* have definite positions, and the principal ones are homologous throughout the group. Pfeiffer[4] adopted a system of terms for them

[1] *Boston Journal of Natural History*, July, 1840, Vol. III, p. 395; April, 1843, IV, p. 350.

[2] *Annals of the Lyceum of Natural History of New York*, Vol III (1867), p. 207.

[3] *Proc. U. S. Nat. Mus.*, 1888; *Proc. Acad. Nat. Sci. Phila.*, 1890; *Nautilus*, 1890 to 1899.

[4] *Monographia Heliceorum Viventium*, II, p. 300.

in 1848 which was excellent, but not sufficiently detailed. Most later authors have followed this terminology more or less closely. In 1888 Dr. V. Sterki,[5] in an excellent paper on *Vertigo*, proposed to designate the principal folds by letters and the accessory ones by numerals. This system, while justly discriminating between the constant and variable folds, is not sufficiently self-explanatory to be generally useful in descriptive work, and would require modifications as well as additional symbols to adapt it to the description of the numerous exotic Pupidæ with a great number of folds or teeth.

We therefore offer below a revised terminology of the aperture armature, applicable to all Pupidæ, and requiring no especial reference to a key, as the terms are to a large extent self-explanatory.

The folds in *Pupa* are probably not truly homologous with those of *Clausilia*, though some occupy the same positions. It is therefore not practicable to use the same set of terms; but we consider it essential to adhere to the principles used in the terminology of the aperture armature of *Clausilia* as set forth by Messrs. E. A. Smith and B. B. Woodward.[6] The plan is to call all projections upon the parietal wall and columella "lamellæ," those within the basal and outer walls of the aperture "plicæ" or folds. The nomenclature of particular folds is then as follows:

---

[5] *Proc. U. S. Nat. Mus.*, XI, 1888, p. 369, Pl. XLII, fig. 5.

[6] *Annals and Magazine of Natural History* (6 Ser.), V, 1890, p. 209. One must actually use the perfected *Clausilia* scheme as set forth in this paper to appreciate its great utility. Fifty years of development have resulted in a plan of consummate simplicity for such a complex subject. Messrs. Smith and Woodward deserve the gratitude of conchologists for their admirable exposé. Compared to this, *Pupa* is simplicity itself. It is much to be regretted that recent French authors do not adopt the Schmidt-Bœttger nomenclature in describing Clausilias.

	Terminology Adopted.	Dr. V. Sterki. 1888.	Dr. V. Sterki. 1889–1898.	Dr. L. Pfeiffer. Monogr. II, 1848.	Corresponding Folds in *Clausilia*.
Upon the parietal wall	Angle lamella	1	Angulo-parietal	lamella angularis	
	Parietal lamella	A	Apertural	lamellæ parietales	Lamella superior
	Infraparietal lamella	2	Infraparietal		Lamellæ interlamellares
Upon the columella	Supracolumellar lamella			lamellæ columellares	
	Columellar lamella	B	Columellar		Lamella inferior
	Subcolumellar lamella				L. subcolumellaris
Within the basal and outer lips.	Basal fold	C	Basal	Plicæ palatales	Plicæ palatales
	Infrapalatal folds	3, 4			
	Lower palatal fold	D	Lower palatal		
	Interpalatal folds				
	Upper palatal fold	E	Upper palatal		Plica principalis
	Suprapalatal folds	5, 6			Plicæ suturales

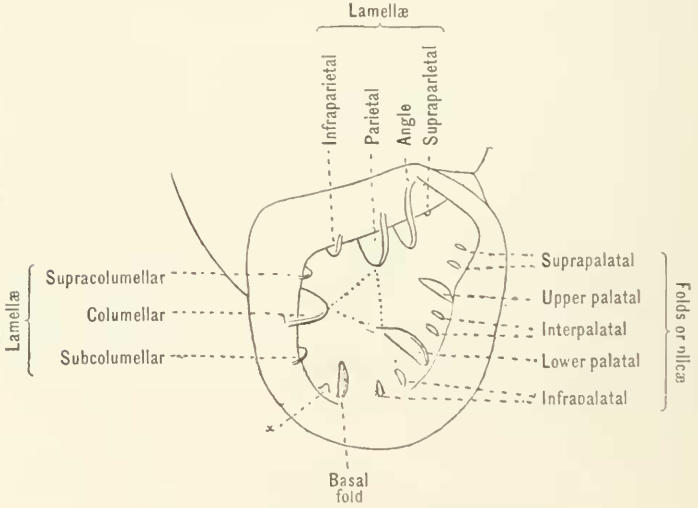

Fig. 1. Terminology of lamellæ and folds.

It will be seen that this is merely an amplification of Pfeiffer's terminology of 1848.

But few Pupidæ have all of the folds named, and some of them are rarely present in American species. Their positions are shown in

the annexed diagram, fig. 1, which is a composite, not representing any special species. The infraparietal, supra- and subcolumellar lamellæ and the infra-, inter- and suprapalatal folds are "secondary" in nearly all groups, and often vary in the species. The others are more constant, and vary but little *in position* when developed. *The parietal and columellar lamellæ and the lower palatal fold are at the angles of a nearly equilateral triangle*, when the said palatal is not deeply immersed. This is useful as fixing the identity of the lower palatal, not always clear in multidentate forms, or in those where there has been extensive reduction of teeth; these three being usually retained when all others have disappeared. Thus in *Pupa blandi* or *triplicata* only the lower of the palatal folds is developed, and in *P. armifera* the lower and upper palatals and a suprapalatal, but no basal fold.

With these preliminaries out of the way, we may proceed to discuss certain American species requiring revision.

PUPOIDES.

Pupoides Pfr., Malak. Blätter I, p. 192, 1854, for *B. nitidulus* Pfr. and *B. marginatus* Say.
Leucochila Martens in Albers, Die Hel. 1860, p. 296, type *Pupa fallax* = *marginata* Say.
Leucochiloides Pfr., Nomencl. Hel. Viv. p. 292, 1878, for *B. cænopictus*, etc.
Pupa sp., *Bulimus* sp. and *Cyclostoma* sp. of Say and authors generally.

A widely distributed genus of toothless Pupæ occurring in equatorial Africa, southern Asia, Australia and both Americas, most of the species closely resembling the one commonly known as "*Pupa fallax*"—the real "*Cyclostoma*" *marginata* of Thomas Say.

Species of the *marginatus* type occur in the United States and West Indies, but in the Andean region of South America, northern Mexico and the adjacent States, Arizona and New Mexico, a group of somewhat dissimilar forms are found, represented by *P. paredesii* Orb., *limensis* Phil., *chordatus* Pfr. and *hordaceus* Gabb.

The names of the leading United States species of *Pupoides* have been involved in errors almost from the time of their description to the present day; it is thus essential that we go to the original descriptions for our nomenclature.

Pupoides marginatus (Say).

Cyclostoma marginata Say, Jour. Acad. Nat. Sci. Phila., II (1821), p. 172.
Leucochila marginata Say, Tryon, Amer. Jour. of Conch., III (1868), p. 305.
Pupa fallax Say of Gould, Binney and nearly all authors and collectors.
Pupa arizonensis Gabb, Amer. Journ. Conch., II, p. 331 (1866).

The name *Pupa marginata* was used by Draparnaud in 1805, and hence when Say's successors transferred his species from *Cyclostoma* to *Pupa* they sought another and unprejudiced name, in an unlucky day selecting that of "*fallax* Say," which has been perpetuated and passed into general use everywhere. Say himself used "*P. marginata*" in all his references to his species, carefully distinguishing *Pupa fallax* from his *marginata*.

Pupa fallax was described in 1825 from a specimen sent to Say by Dr. T. W. Harris, of Milton, Mass. In 1829, after Say had cast his fortunes with the communist society at New Harmony, Ind., he happened upon the shell again, and forgetting his former description, wrote another *of the same specimen* under the name "*Pupa placida.*"

Say was a masterly diagnostician, and it is interesting to see both how similarly he expresses the characters in the two diagnoses and how excellently he pictures the shell, which was really nothing else than the common European *Buliminus obscurus* Müll.!

The two descriptions are as follows:

Journ. A. N. S., Vol. V, p. 121, 1825.

"PUPA.

"P. *fallax*. *Shell* turreted, pale horn colour; wrinkles rather obtuse, hardly prominent: *suture* rather deeply impressed: *volutions* nearly seven, a little convex: *apex* somewhat obtuse: *aperture* unarmed, suboval, truncated above by the penultimate whorl, less than $\frac{1}{3}$ the whole length of the shell: *labium*[7] nearly transverse, colour of the exterior part of the shell: *columella* reflected, rectilinear, longitudinal, forming an obvious though a rounded angle with the labrum and labium: *labrum* hardly reflected: *umbilicus* narrow.

"Length more than three-tenths of an inch.

"For this species I am indebted to Dr. T. W. Harris, of Milton, Massachusetts.

"It closely resembles P. *marginata* Nob., but is much larger, and the labrum is not widely reflected; when viewed in front it has a reflected appearance, but the opposite view presents only a very limited excurvature."

The Disseminator of Useful Knowledge, II, No. 15, p. 230, July 29, 1829.

"PUPA.

"P. *placida*. *Shell* dextral, cylindric conic, pale yellowish horn colour; *apex* whitish, obtuse: *whorls* six & an half, somewhat wrinkled: *suture* moderately impressed: *aperture* unarmed longitudinally oval, truncate a little obliquely above by the penultimate volution: *columella* so recurred[8] as almost to conceal the umbilicus: *labrum*, with exception of the superior portion, appearing a little recurved when viewed in front, but when viewed in profile this recurvature is hardly perceptible: *umbilicus* very narrow.

"Length over three tenths of an inch.

"Inhabits Massachusetts.

"For this shell I am indebted to Dr. T. W. Harris, of Milton, from whom I have received many interesting species of our more northern regions.

"At first view it might be mistaken for the P. *marginata* Nob., but it is quadruple the size, and the labrum is not reflected and thickened."

It follows from the foregoing that *Pupa fallax* and *Pupa placida* Say become synonyms of *Buliminus obscurus* (Müll.). *Cyclostoma marginata* Say survives as *Pupoides marginatus* (Say) for our well-known species.

[7] Error for *labrum*.

[8] Error for recurved.

Pupoides hordaceus (Gabb). Pl. XXII, fig. 11.

Pupa hordacea Gabb, Amer. Jour. Conch., II, p. 331, Pl. 21, fig. 7 (1866).
Pupa arizonensis Gabb, W. G. Binney, Land and Fresh-Water Shells of North America, 1869, Part I, p. 240, fig. 416; and in subsequent works. Not *P. arizonensis* Gabb.
Pupa arizonensis W. G. Binney, Sterki, Nautilus, III, pp. 118, 119.
Pupa gabbi Dall, Proc. U. S. Nat. Mus., Vol. XIX, 1896, p. 367.
Bifidaria hebes Ancey, Pilsbry, Classified Cat., p. 19; Nautilus, XI, p. 117 (1898). Not of Ancey.
?*Pupa arizonensis* var. *saxicola* Ckll., Zoe, Vol. II, 1891, p. 18. (Round Mt., Custer Co., Colorado.) Not *P. saxicola* Lowe nor Moquin-Tandon.
Pupa gabbi mexicanorum Ckll., Nautilus, X, p. 143.
Not *Pupa hordeacea* W. G. Binney; not *Bifidaria hordeacea* Sterki or Pilsbry.

The original description of this species is as follows:

"*Pupa hordacea* Gabb.

"Description.—Shell very small, cylindrical; apex obtuse; whorls 6, convex; suture well impressed, smooth, thin, horn-color; aperture small, rounded below, unarmed, lip narrowly reflected and white; base umbilicate, the umbilicus bounded by an angle.

"Dimensions.—Length .11, width .04 inch.

"Locality.—With the preceding" [Fort Grant, at the junction of the Arivapa and San Pedro rivers, Ariz. Collected by Dr. G. H. Horn].

Gabb's figure is very small and leaves much to be desired, but it has the merit of agreeing with the diagnosis in being toothless. His type lot was a mixture of several species. He did not even take the trouble to separate out *P. procera;* and consequently the specimens he sent out misled conchologists who did not verify them by the description. Mr. Binney figured and described the true *hordacea* as "*arizonensis,*" and the associated *procera* as "*hordeacea.*" Sterki detected the incongruity between *arizonensis* of Gabb and *arizonensis* Binney, but did not recognize the identity of the latter with *hordacea* Gabb. Dall renamed Binney's *P. arizonensis,* calling it *P. gabbi.* In the *Catalogue* published by Messrs. Johnson and Pilsbry, the latter accepted Binney's identification of *P. hebes* Ancey with *arizonensis* W. G. B.,[9] and used that name for the unfortunate species.

So far we have only wandered deeper into the labyrinth, and the several gentlemen who have handled the matter certainly cannot by any hyperbole be called Ariadnes. We find the guiding thread

[9] *Man. Amer. Land Shells,* p. 173, footnote; 2d Suppl. to *Terr. Moll.,* V, p. 40.

in *Gabb's original description* and one of his original specimens (Pl. XXII, fig. 11). *The true Pupa hordacea of Gabb is arizonensis of Binney not Gabb, hebes of Pilsbry not Ancey, gabbi of Dall and mexicanorum of Cockerell.*

The systematic position of this species has not been correctly defined hitherto. It has real affinity to *P. chordatus* Pfr., of Lower California and Mazatlan, and *P. paredesii* Orb., of Ecuador. It has been considered by some to be a toothless *Bifidaria*, allied to *corticaria*, but the characters of the shell seem clearly against this view.

The degree of surface wrinkling or ribbing is somewhat variable, but we have not seen a smooth example, and do not doubt that it is always irregularly ribbed. The specimen figured has 5½ whorls, and measures, length 3.5, diam. 1.6, diam. of penult. whorl 1.36 mm. It is the same shell figured by Binney as *P. arizonensis* and now deposited in the Binney and Bland collection in the American Museum Natural History, New York city. Some of the New Mexican specimens collected by Prof. Cockerell are slightly larger and a little rougher.

We know nothing of the Colorado shells called *P. arizonensis* var. *saxicola* by Mr. Cockerell.

PUPA.

This genus is well developed in Europe, Asia, Africa and Australia, but is represented in America by only six species, so far as we now know. Five of these belong to the holarctic group of *P. muscorum*, while one, *P. sterkiana* Pils., is strongly differentiated, and is the only member of the genus ranging south of the United States. It belongs to the Lower Californian fauna.

Pupa hebes Ancey. Pl. XXII, figs. 9, 10.

P. hebes Anc., Le Naturaliste, 1881, p. 389. Not *P. hebes* Pilsbry, Nautilus, XI, p. 117.

P. arizonensis W. G. Binney, 2d Supplement to Terr. Moll., V, p. 40, Pl. III, fig. 12.

Shell rimate, cylindrical, bluntly rounded at the ends, thin, light chestnut colored, not glossy, very slightly striate. Whorls 6½, the earlier 3 rapidly increasing, the rest of about equal width, quite convex, the last whorl ascending in front, its latter third somewhat compressed, the base showing a blunt projection when viewed in profile; a decided contraction behind the outer lip, but

scarcely any crest. Aperture truncate-oval, slightly oblique, without lamellæ or folds, though there is a slight projection on the columella, far within. Peristome thin, narrowly expanded, not in the least thickened within Length 3.5, diam. 1.8 mm.

Near Jerome, Ariz.; Page's ranch, Walnut Gulch and top of Mt. Mingus (about 8,500 feet alt.); collected by Rev. E. H. Ashmun. White Pine, Nev., Ancey's type locality.

Well distinguished from *P. muscorum* and *P. blandi* by the absence of a callus within the lip, as Mr. Ancey pointed out in his original description. The original types are lost,[10] but we have no hesitation in identifying the shells found by Mr. Ashmun near Jerome, Ariz., with Mr. Ancey's species, as they completely fill the requirements of his diagnosis. The senior author of this paper formerly identified *hebes* with *P. arizonensis* of W. G. Binney, following a statement by the latter authority that the two were identical.[11] Attention to Mr. Ancey's diagnosis should have prevented such a *rapprochement.*

BIFIDARIA.[12]

This group was founded by Dr. V. Sterki to contain certain Pupæ in which the parietal and supraparietal lamellæ converge to form a single bifid or twisted lamella, or lie adjacent; there is a single columellar lamella and, as a general rule, two palatal folds and one basal. He included a large number of American species and a few forms from Asia, *hunana* Gredl., *strophostoma* Mlldff., *armigerella* Reinh., *recondita* T.-C., etc.

The most cursory acquaintance with *Pupidæ* develops the fact that there is a widespread and general similarity in the lamellæ and folds, and in species of many groups, in Europe, South Africa, Australia and America the development of the principal plaits is not conspicuously dissimilar. However, taking the entire structure into consideration, there is no *Pupa* in Europe or South

[10] "Unfortunately I cannot forward to you a specimen of the typical lot of my *Pupa hebes*. The two typical examples have been destroyed. The glass tube containing them was broken when I removed from Boghari, my former residence, and I could find no trace of the shells." *Ancey in litt.* July 16, 1900.

[11] Second Supplement to *Terr. Moll.*, V, p. 40, Pl. 111, fig. 12. It is only fair to say that Mr. Binney did not have his *arizonensis* by him for actual comparison, else the union would probably not have been made.

[12] *Bifidaria* Sterki, in Pilsbry, *Proc. A. N. S.*, 1891, p. 315 (for *P. contracta* and *P. servilis*); Sterki, *Nautilus*, VI, pp. 4 (May, 1892) and 99 (Jan., 1893).

Africa which could be referred to the *P. humana* group of eastern Asia or the *P. armifera* group of America.

The distribution of *Bifidaria* outside of America is extensive. In Japan (*B. armigerella* Reinh.) and China (*B. monas* and *atoma* Heude) the species are minute, and while referable to the typical section of the genus, have affinities with *Albinula*. In India we have the type of a new section in *B. plicidens* Bens.,[13] with a typical *Bifidaria* exceedingly similar to *B. hordeacella* Pils., in *B. mimula* Bens. This type extends to the islands of the Indian Ocean near Madagascar, where we find in *B. seignaciana* C. and F., of Nossi-Be, and *tripunctum* Morel., of Mayotte, forms very close to *mimula* and *hordeacella*, while *B. lienardiana* Cr. (Rodriguez Island), and *exigua* H. Ad.[14] (Mauritius), are so near the Antillean *B. servilis* Gld. that one can hardly believe them different. It is not impossible that these Indian and insular species, which so wonderfully mimic widespread West Indian forms, have really been imported on plants or otherwise from the Antilles, as some Stenogyroid species, *Ennea bicolor*, *Vallonia*, etc., have been carried over the globe. No South African species referable to *Bifidaria* have been found.

In the East Indies *Bifidaria* is represented almost everywhere, though not numerously so far as known. Von Möllendorff records four species from the Philippines—*artensis* Montr., *pediculus* Shuttl., *capillacea* Dohrn and *euryomphala* Mlldff.

Melanesia has the widely distributed *B. pediculus* (Shuttl.) and in Australia there are numerous species of the type of *B. pediculus*.

In Europe there are apparently no recent species, but *P. flexidens*, *obstructa* and *didymodus* Al. Br., of the Main Basin (Lower Miocene), and *heterodus* Bttg. (Middle Miocene) may perhaps be referred here. The recent *P. theeli* Westerlund, of Siberia, from the description seems to be a *Bifidaria*.

It is worthy of note that it is only in America and eastern and

[13] Section *Bensonella* nov. Peristome continuous, calloused within except near the posterior angle of the aperture; parietal lamellæ long, separate, the angle lamella deeply entering, an infraparietal developed. Palatal folds standing in a row within the labial callus, their number increased by accessory folds. Texture and whitish color of *Bifidaria*. Type *Pupa plicidens* Bens.

[14] This is not *Pupa exigua* Say, and if a valid species, which is doubtful, the name must be changed.

southern Asia that any great diversity of type occurs. The East Indian, Polynesian and Australian species are all of a single rather generalized type characterized by the imperfect union of the parietal and angle lamellæ.

Hypselostoma is an allied genus, with dark-brown, opaque shell and more produced "neck," though some *Bifidariæ*, such as *B. perversa*, parallel it in the latter respect. Genera are rather cheap in *Pupidæ*, but on the whole *Hypselostoma* seems rather nearer to *Nesopupa* and even *Torquilla* than to *Bifidaria*. As a subgenus of *Hypselostoma* we would rank *Boysidia*,[15] in which the conic spire, brown color of the shell-substance and continuous peristome, as well as the dentition, agree. Both of these groups may have the parietal and angle lamellæ either independent or united. We think it will be obvious to any one who will compare several species of *Boysidia*, such as *hunana* Gredl., *strophostoma* Mlldff., *moellendorffi* Bttg., with a number of the less modified forms of *Hypselostoma*, that the relationship is very close. *Hyp. tubiferum*, the type of the genus, is one of the most extreme modifications, and not a fair criterion.

Other Oriental *Pupidæ*, such as *Boysia* Pfr., which may perhaps be a modification of *Pupisoma* Stol., and *Aulacospira* Mlldff., while finding their place in this family, in all probability are not at all closely allied to the forms under consideration.

Regarding the status of the name *Bifidaria*, it should be mentioned that in 1881, Dr. O. Bœttger proposed to transfer *P. fallax* Say from *Leucochila* to *Buliminus*, and retained the name *Leucochilus* for the species allied to *P. armifera* Say,[16] which would thus replace *Bifidaria*. But as the type of *Leucochila* had been expressly stated by Prof. von Martens to be *Pupa fallax* Say (by which *marginatus* Say was intended), such a restriction was unlawful; and as Bœttger considered his group only a modification or restriction of *Leucochila* Martens, I do not see that by changing the gender of the name he rendered it any more acceptable.

In America the *Bifidaria* group has been modified into several subordinate groups, some of wide range and numerous species. These groups may be tabulated thus:

[15] *Boysidia* Ancey, *Le Naturaliste*, May, 1881, p. 407 (for *P. hunana* and *P. dorsata*). *Gredleriella* Mlldff., *Jahrb. d. d. Malak. Ges.*, XI, 1884, p. 179 (for *Pupa hunana*), is a synonym.

[16] Von Martens' *Conchologische Mittheilungen*, II, p. 64.

Key to American Sections of Bifidaria.

a.—Parietal and angle lamellæ independent, long; a columellar lamella and palatal folds present.

b.—Palatal folds deeply immersed, hardly or not visible from the aperture, the lower *behind*, rather than below, the upper, the basal transverse; last whorl straightened and free, the peristome continuous, . *Immersidens* P. and V.

*b*¹.—Palatal folds normal in positon, not deeply immersed, visible from in front; last whorl normal in shape, not built forward nor free, ... *Sterkia* Pils.

*a*¹.—Parietal and angle lamellæ very short, small and tuberculiform; no palatal folds; shell cylindrical, . . *Privatula* Sterki.

*a*².—Parietal and angle lamellæ elongate, more or less united, either by a callous ridge or so extensively as to appear like a single sinuous or emarginate lamella.

b.—Aperture not much contracted by the teeth. Shell cylindric or cylindro-conic, rather narrow; parietal and columellar lamellæ moderate or small, the latter a simple entering lamella; palatal folds 3 (sometimes fewer), not situated upon a callous ridge, . . . *Bifidaria* s. str.

*b*¹.—Throat nearly closed by the teeth. Shell oblong or conic, rather wide; parietal and columellar lamellæ long and tortuous, the latter more or less vertical; palatal folds several, situated on a ridge, . . . *Albinula* Sterki.

*a*³.—Parietal lamella simple; no angle lamella; palatals normal or increased by accessory denticles, often standing upon a callous ridge, ... *Vertigopsis* Ckll.

Bifidaria dalliana Sterki. Pl. XXII, fig. 8.

B. dalliana Sterki, Nautilus, XII, p. 91, Dec., 1898.

Nogales (type locality), Santa Rita Mts., and Tempe, Ariz., also Mexican side of line near Nogales, Ariz.

A very small species, length 1.6 to 1.8 mm., differing from *B. hordeacella* chiefly in the much less united angle and parietal lamellæ, the transverse position of the basal fold, and the more deeply immersed lower palatal.

B. pilsbryana is an equally small species, with a simple parietal amella and three subparallel palatal folds, the lower palatal not immersed. It stands between the typical *Bifidarias* and *Verti-*

gopsis, but on account of the absence of an angle lamella we are disposed to rank it with *B. pentodon*, in *Vertigopsis*.

Bifidaria hordeacella (Pilsbry). Pl. XXII, fig. 3.

Pupa hordeacella Pils., Proc. A. N. S. Phila., 1890, p. 44, Pl. 1, fig. *g* to *k*.
Pupa hordeacella Binney, Fourth Suppl. to Terr. Moll., V, p. 193, Pl. 2, fig. 2.
Pupa hordeacella Dall, Proc. U. S. Nat. Mus., XIX, 1896, p. 367.
Pupa hordeacella Sterki, Nautilus, IV, p. 141; VI, p. 4.
Pupa hordeacella Ckll., Nautilus, X, pp. 42, 43.
Bifidaria hordeacella Pils., Nautilus, XI, p. 117; Classified Cat., p. 19.

Ranges from Cape May, N. J., and St. Simon's Island, Ga., to the St. John's river valley and Sarasota Bay, Fla., west to Indian Territory (Fort Gibson) and southern Texas, and New Mexico. We have not seen it from the Antilles.

The small size (length 2.1, diam. .8 mm.) and slender contour, nearly simple or slightly emarginate parietal lamella and thin outer lip distinguish it from *B. rupicola* and *procera*. In Texas and the West it is light brown, but in Florida is often thinner and corneous. Almost always associated with *B. rupicola* in the eastern Gulf States, and with *B. procera* in the West, but readily separated from either by size alone.

Bifidaria hordeacella parvidens (Sterki). Pl. XXII, fig. 2.

P. hordeacella parvidens Sterki, Nautilus, XII, p. 128; XIII, p. 16.

Mescal Gulch, near Jerome, and Jerome, Ariz.

Easily distinguished by the very small size or obsolescence of the upper palatal and basal folds.

Bifidaria procera (Gould). Pl. XXII, figs. 6, 7.

Pupa procera Gld., Bost. Journ. N. H., III, 401, Pl. 3, fig. 12 (1840); IV, p. 359, Pl. 16, fig. 12.
Pupa procera Gld. Sterki, Nautilus, IV, p. 140; VI, p. 4.
Pupa procera Gld., Ckll., Nautilus, X, p. 43.
Bifidaria procera Gld., Pilsbry, Nautilus, XI, p. 117; Class. Cat., p. 19.
Pupa carinata Gld., *olim*, an abnormal shell.
Pupa gibbosa Say, Küster, and *P. minuta* Say, Pfr. Not of Say.
Pupa rupicola Say, W. G. Binney, Land and Fresh-Water Shells of N. A., I, p. 243, figs. 423, 424; Man. Amer. Land Sh., p. 328, fig. 354. Not of Say.
Pupa pellucida Pfr., Strebel, Beitr. Mex., Theil IV, p. 91, Pl. 4, fig. 12; Pl. 15, fig. 10.
Pupa hordeacea Gabb, W. G. Binney, L. and F.-W. Sh., I, p. 241, fig. 417; Man. Amer. L. Sh., p. 173, fig. 165 (bad). Not *P. hordacea* Gabb!

The large size, subcylindrical form, distinctly bifid parietal lamella and deeply situated lower palatal fold separate this

species from *rupicola* and *hordeacella*. It ranges from Baltimore, Md., to South Carolina, west to Kansas, and southwest to Arizona and Mexico. We have seen no specimens from Florida.

Binney's description and figure of "*P. hordeacea*" are surprisingly inaccurate, and contradict each other. There is no species known in America which agrees even approximately with either. They were doubtless made from a specimen sent by Gabb, who had *procera* mixed with his *hordacea;* but it is safe to say that they inaccurately represent the shell.

Bifidaria procera cristata P. and V., n. var. Pl. XXII. figs. 4, 5.

Pupa and *Bifidaria hordeacea* Gabb, Sterki, Nautilus, IV, p. 141; VI, p. 4, 102; X, p. 42, 43. Pilsbry, Nautilus, XI, p. 117. Not *P. hordacea* Gabb.

Angle and parietal lamellæ more completely united than in *B. procera*, hardly bifid; crest behind the outer lip very strong. Average size slightly greater.

Length 2.8, diam. 1.2 mm.

Types No. 78,694, coll. Acad. Nat. Sci. Phila., from Camp Verde, Ariz., collected by Rev. E. H. Ashmun.

This Southwestern form is readily distinguishable from *B. procera* by the above characters. It ranges eastward to central Texas.

Bifidaria rupicola (Say). Pl. XXII, fig. 1.

Originally described from Fort Picolato on the St. John's river, not far from St. Augustine, Fla., this species is before us from South Carolina and St. Simon's Island, Ga., southward to Miami, Fla., and west to New Orleans, La. It is abundant along the St. John's river, has not yet turned up in the Texas litoral, but occurs in Cuba and Bermuda.

Compared with *B. procera*, this species tapers much more, a point Say laid stress upon. The outer and basal margins of the lip are broad, flatly spreading and thickened within, but at the posterior or upper curve of the outer lip it abruptly becomes narrower. The parietal lamella is moderately emarginate, and the lower palatal fold is less immersed than in *procera*. There is a very narrow but distinct crest close behind the peristome. The color is subtransparent whitish-corneous or brownish-corneous. Length about 2.4, diam. 1.1 mm. It is larger and more tapering than *B. hordeacella*, which has not the spreading, calloused lip of *B. rupicola*.

Cf. also Sterki, *Nautilus*, IV, 139, where the characters are well indicated.

In addition to the preceding species, another form, insufficiently defined, calls for notice, *B. riograndensis* Sterki. In the *Nautilus*, IV, p. 142, Dr. Sterki gives descriptive notes on a form from Hidalgo, Tex., under the head "*Pupa* ——" It is stated to resemble *P. servilis* Gld., except in having *an infraparietal lamella* and a very long lower palatal fold. In *Nautilus*, VI, p. 4, he lists a "*P. riograndensis* Sterki MSS." from the same locality, without description or reference to his previous note. Of course there is no necessary connection between the nameless *Pupa* with a description and the later nude name; but we have little doubt that the two are identical, though Dr. Sterki in introducing a new name into the list has left others to guess at what it may be.

We have not seen specimens, and in the eight years since the name *riograndensis* was published it has not been made good by a description. If our theory regarding its identity be correct, it may be known by the infraparietal lamella, which is present in no other known *Bifidaria* of the United States fauna.

VERTIGO.

This genus was established in 1774 for the single species *V. pusilla*, of central Europe. Some authors have proposed to unite *Vertigo* and *Pupa* in one genus, bearing the latter name;[17] but the fact that *Vertigo* is the prior name seems to have escaped these gentlemen. *Pupa* was not established until 1802.

Vertigo seems to be neither more nor less distinct than *Bifidaria*, *Torquilla*, *Fauxulus*, *Hypselostoma* and other Pupoid groups now ranked as genera; and while we freely admit that the differences between these groups are not great, it is obvious that if all be united into one genus, that must be called *Vertigo*. The recognition of several genera among the Pupæ seems to us to be a wiser course, as otherwise the relationships of the forms would be lost sight of in so vast and composite a genus.

Vertigo has a wide range in the three northern continents, but apparently does not occur below the equator. The American forms have been studied by Dr. V. Sterki, who has cleared up a

[17] Even by Prof. von Martens, in the *Biol. Amer. Centrali.* 1898, this course has been taken.

number of doubtful points and defined numerous species hitherto unknown in the fauna. There yet remain some wholly undefined names in the literature, which have been awaiting characterization for many years; others, while known by brief diagnoses, call for fuller exposition, while a species defined by Thomas Say seventy-six years ago is now for the first time recognized as valid, and restored to its usurped place.

In America there are several outlying species for which sectional divisions of *Vertigo* have been established—*Nearctula*, *Haplopupa*, *Bothriopupa* and *Angustula*. The last group was established for *V. milium* and *V. venetzii*, the latter a European species, and (under the synonymous name, *V. plicata*) one of the two types of *Vertilla* Moquin-Tandon. *V. pusilla* Müll. was the other species of *Vertilla*, and as it had been made the sole type of *Vertigo* by Müller, it must be removed from Moquin-Tandon's group, leaving *V. plicata* (= *venetzii* = *angustior*) the type of *Vertilla*. Or, to tabulate the matter:

Types of *Vertilla* Moq., 1855 { pusilla = Type of *Vertigo* Müller, 1774. { venetzii, milium } Types of *Angustula* Sterki, 1889.

It would seem from this that *Vertilla* must replace *Angustula* as a subgeneric name for *V. milium* and *venetzii*, the latter species being the type. Several well-known experts in nomenclature to whom we have submitted the case agree in this opinion. It is rather a pity, because Moquin-Tandon had no idea of the really peculiar characters of *V. venetzii*, which were first exposed by Dr. Sterki.

The Group of Vertigo modesta.—The Vertigos of the *californica* and *modesta* groups agree in *lacking a basal fold*, or tooth near the base of the columella. The parietal and columellar lamellæ and lower and upper palatal folds are developed and nearly equidistant, giving a somewhat cruciform outline to the aperture. Sometimes the angle lamella appears, but never any others; and in a few forms several of the teeth become reduced or lost. The outer lip is not very noticeably caught in at its upper third to form a "sinulus," as it is in most species of *Vertigo*. These features give a particular aspect to the group which Dr. V. Sterki has recognized in taxonomy by the name "*Nearctula*." This distinction, however, is

more apparent than real, the species of the *modesta* group really being exceedingly close to such forms as *V. gouldii*, and in fact *V. columbiana* is hardly separable specifically. For this reason, we think *Nearctula* must be restricted to the single species *V. californica*, characterized by its ribbed, opaque shell, and the other species associated therewith by Dr. Sterki will group better among the true *Vertigos*.

The group of *Vertigo modesta* includes species with *a crest varying from very low to strong, behind the lip;* in this respect differing from the group of *V. californica*, the species of which have no crest, and are rather less glossy.

The American species are Canadian or boreal, extending southward in the Rocky Mountain region. Their number has been estimated at as many as eight species and three varieties (Sterki, 1892); but this seems to us to be too generous. We are able to distinguish four species, and several varieties may conveniently be recognized, though their determination is at times difficult from the intergradation with parent stocks. We omit from the account *P. hoppii* Möller, a Greenland species not shown to occur on the mainland of North America (conf. *Nautilus*, XII, 104), and *P. borealis* Morelet, described from Kamchatka, and not known to us from America, the Alaskan Pupæ of this type being referable to *V. modesta* Say, so far as we have seen.[18]

The forms of the *V. modesta* type make a beautiful variation-chain, or "*Formen-kette*," as recent German authors term these series of species connected by intermediate variations in the living fauna. The relationships of the forms may be expressed diagrammatically, dashes representing breaks in the chain; figures referring to Plate XXIII:

castanea, fig. 5.
castanea, fig. 4.
modesta, fig. 3—*modesta*, fig. 6. *corpulenta*, fig. 7.
modesta parietalis, fig. 2.
parietalis, fig. 1.
|
concinnula, fig. 8.
|
arizonensis, fig. 9—*utahensis*, fig. 10—*columbiana*, [fig. 11.

The group not separated by dashes is shown by our series to be

[18] We have not seen Kamchatkan *P. borealis*, but it is evidently very near *V. modesta*, perhaps only a form of that species.

completely connected by intermediate specimens. This is not sufficiently shown in the plate because, in order to emphasize the characteristics of geographic races, we have selected the most strongly differentiated individuals for figuring. In view of the fact that the Rocky Mountain region is most imperfectly explored for small snails, we hold the opinion that still more connecting links will be found, and probably *V. concinnula* will become a subspecies of *modesta*. It is not impossible that *V. dalliana* will fall into line as a terminal member of the series, beyond *castanea*, in which all teeth have been lost.

Variation among individuals from one place, as well as geographic racial differentiation, is ubiquitous among these pygmy snails, though less striking to the eye than in larger forms, or those in which color or sculpture is more modified. The development of the teeth is greatest in the mountain forms, *concinnula* (Pl. XXIII, fig. 8) and *arizonensis* (Pl. XXIII, fig. 9), occurring at high altitudes; while *modesta* (fig. 3) and *castanea* (figs. 4, 5) are at least mainly from much lower levels. The form of *modesta* from the Iowa loess is also more or less deficient in teeth. But we do not think to correlate this character of the shells with mere elevation, for it is more likely to be a reaction due to some unknown element of the faunal environment, such as minute snail-eating insects.

Vertigo concinnula Cockerell. Plate XXIII, fig. 8.

Vertigo californica Ingersoll, Bull. U. S. Geol. Surv. Terr., I, p. 128 (1875). No description. Not of Rowell.

Vertigo ingersolli Ancey MSS. in Cockerell, J. of Conch., Leeds, VI, 1889, p. 64 (name only, substituted for *P. californica* Ing. non Row.); British Naturalist, 1891, p. 100 (not seen); Sterki, Nautilus, VI, 1892, p. 5, with varieties *haydeni* Anc. and *accedens* Anc. (names only); Cockerell, Nautilus, X, 1897, p. 135 (identity with *concinnula* affirmed from part of original lot).

Vertigo concinnula Cockerell, Nautilus, X, 1897, p. 135.

Pupa concinnula Ckll., Pilsbry, Nautilus, XI, 1898, p. 119; Class. Cat. L. Sh. Amer., p. 21; Nautilus, XII, 1899, p. 103.

Shell ovoid-cylindrical in outline, slightly tapering toward the blunt apex; solid and somewhat opaque, so that the folds of the outer lip are usually only dimly seen through from the outside. Surface shining, irregularly, obliquely striate. Whorls 5, apical 2 whitish, the rest chestnut-brown, often with numerous irregularly scattered spots and flecks of very light buff. Whorls quite convex, the last slightly ascending toward the aperture, its latter half very decidedly flattened on the outer-inferior portion, this

part bearing a low broad wavelike "crest" or ridge behind the lip, and then slightly constricted. Umbilical rimation short, imperforate. Aperture rounded, truncate above; peristome a little expanded; parietal wall bearing a rather strong entering lamella in the middle, and usually a smaller angle lamella to the right of its outer end; columella with a strong deep-seated entering lamella; outer lip with two rather low long palatal folds, the lower one longest. Alt. .2, diam. 1.1 mm.

The dull, rather opaque shell, cylindrical and small, with long palatal folds and parietal lamella, separate this from *V. modesta* and its varieties, but it certainly approaches *V. modesta parietalis*, which, however, is larger and smoother. The form of *modesta* from Labrador agrees with *concinnula* in having the penultimate whorl distinctly striate. The larger size, more cylindrical shape and presence of an angle lamella distinguish it from typical *coloradensis*. According to Cockerell, it occurs at higher elevations than *V. coloradensis*, between 6,000 and 10,000 feet.

Custer and Summit counties, Colo. (Ckll.); Jemez Mts., N. M. (Ashmun). Numerous other localities in Colorado are given by Ingersoll.

The specimens from the Jemez Mts. have a much stronger crest behind the lip than those from Colorado, and are less opaque.

Vertigo modesta (Say). Plate XXIII, figs. 2, 3, 6.

Pupa modesta Say, Long's Second Expedition, II, appendix, p. 259, Pl. 15, fig. 5 (1824).
Pupa decora Gld., Proc. Bost. Soc. N. H., II, p. 263 (1848). Fig. in text.

More cylindrical than *V. corpulenta*, with one whorl more; crest moderate or low; teeth typically four, parietal, columellar, upper and lower palatal; but sometimes a fifth, the angle lamella, is added.

Fig. 3 is drawn from a specimen from Laggan, Alberta, collected by Rev. George W Taylor. Length 2.5, diam. 1.3 mm.; whorls $5\frac{1}{2}$.

Fig. 2, Dyea Valley, Alaska, collected by Mr. P. B. Randolph. Length 2.4, diam. 1.3 mm. The form is a little stouter than typical, and the crest perceptibly stronger. In some specimens the teeth are slightly better developed than in typical *modesta*, and some have a second parietal lamella. This lot is perfectly intermediate between *modesta* and *parietalis*.

A Labrador specimen (Pl. XXIII, fig. 6) is smaller, length 1.9, diam. 1.2 mm., about the size of *concinnula* Ckll., typical in teeth, but closely and deeply striate on the penultimate whorl. The crest is slighter than in typical *modesta*.

The type locality of *V. modesta*, Northwest Territory, was somewhere in northern Minnesota, southern Manitoba, or near the western end of Lake Superior, on the route of Major Long's second expedition (see map in volume cited above). *P. decora* was also described from Lake Superior. From this region the species ranges to Labrador, to the Rocky Mountains and northward to Alaska It also occurs in the loess deposit at Iowa City, Ia.; many of these specimens having the upper palatal fold subobsolete or wanting, as in the variety *castanea*.

P. modesta has been erroneously placed in the synonomy of *Vertigo ovata* hitherto, but reference to the original description shows it to be identical with *decora*. Say's description is as follows:

"*P. modesta*. *Shell* dextral, suboval, minutely wrinkled; *apex* obtuse; *whorls* six; *umbilicus* distinct; *aperture* obliquely subovate; *labium* with a prominent compressed semioval tooth equidistant from the extremities of the labrum, and a somewhat conic one rather below the middle of the columella; *labrum* not reflected, joining the preceding whorl at its upper extremity with a curve; bidentate, lower tooth placed opposite to that of the middle of the labium, the other smaller and placed a little above. Length less than one-tenth of an inch. Inhabits the Northwest Territory."

V. modesta parietalis (Ancey), n. v. Plate XXIII, fig. 1.

Shape somewhat more obese than *V. modesta*; whorls about 5; teeth 5, the angle lamella being developed. This form is intermediate between *modesta* and *corpulenta* in contour and size. It may be a case of dimorphism rather than a true variety, as it occurs in some places with 4-toothed shells, and with the fifth lamella in various stages of development in apparent adults, as in the Dyea Valley. The figured specimen is from Ogden Cañon, Utah, collected by Hemphill, with *corpulenta*.

V. modesta corpulenta (Morse). Plate XXIII, fig. 7.

Isthmia corpulenta Morse, Ann. Lyc. Nat. Hist. of N. Y., VIII, p. 210, fig. 7 (1865).

Typically much shorter than *modesta*, more obese, with only about 4½ whorls. Teeth 4, short. Type locality, Little Valley,

Washoe county, Nev. It occurs also in Utah, the figured specimen being from Ogden Cañon. The lower palatal fold is decidedly tubercular, at least in typical *corpulenta*, and the surface is smooth. Length 2.1, diam. 1.3 mm.

Vertigo modesta castanea (Sterki), n. v. Plate XXIII, figs. 4, 5.

V. castanea Sterki, Nautilus, VI, 1892, p. 5.
P. castanea Sterki, Pilsbry, Nautilus, XI, 1898, p. 119; Class. Cat. Land Shells Amer., p. 21.

Shell oblong or cylindric-oval, glossy, somewhat translucent; chestnut, sometimes with some whitish stripes. Whorls $4\frac{3}{4}$–5, the last with a moderate crest behind the lip. Teeth very small, placed as in *corpulenta*, the lower palatal largest, columellar usually developed, parietal very small or obsolete, upper palatal wanting or minute. Alt. 2.3, diam. 1.4 mm.

Fish Camp, Fresno county, Cal. (Hemphill). Lake county, Cal. (Sterki).

This stands toward *V. modesta* as var. *diegoensis* toward *V. californica*. Both are subterminal members of series running from toothed forms toward a toothless condition. The specimens described and figured are from the locality first mentioned above. In the series before us, this intergrades directly with *modesta*. The specimens vary greatly in development of the teeth.

Vertigo columbiana Sterki MSS., n. sp. Pl. XXIII, fig. 11.

V. columbiana Sterki, Nautilus, VI, 1892, p. 5 (name only).
Pupa columbiana Sterki, Pilsbry, Nautilus, XI, 1898, p. 119; Class. Cat., p. 21, No. 212; Nautilus, XII, p. 103.
V. columbiana var. *utahensis* Sterki, Nautilus, VI, 5 (name only).

Shell very minute, cylindric-oval, perforate, thin, pale corneous-brown, somewhat transparent, glossy and weakly striatulate. Whorls nearly 5, convex, the last expanded in a low crest very close to the lip, not noticeably constricted in front of the crest. Aperture truncate-oval, 4-toothed, the peristome thin, hardly expanded; parietal lamella short and high, columellar a little smaller, lower palatal a short conic fold continued inward; upper palatal smaller, shorter, almost tuberculiform; all the teeth white and the palatals showing through the outside wall. Alt. 1.9, diam. 1.1 mm.

Vancouver Island (George W. Taylor); Olympia, Tacoma and Seattle, Wash. (Henry Hemphill); Douglas county, Ore. (F. H. Andrus).

Types of above description and figure are Nos. 60,468 and 68,881, coll. A. N. S., from Vancouver Island.

An exceedingly small species with four well-developed teeth. The palatal folds are rather shorter than in *V. coloradensis* or *V. concinnula*, both of which are, moreover, more striate and less transparent. The specimens from Vancouver Island, Washington and Oregon are quite uniform in all respects. The above references to literature refer to the name in lists, as there has been no definition of the species.

V. columbiana stands perilously near forms of *V. gouldii* without the basal fold. It may be merely an occidental subspecies of *gouldii;* but in a considerable series examined, there never seems to be a trace of the basal fold. It is this which induces us to give the form specific standing.

Vertigo columbiana utahensis Sterki MS., n. var. Plate XXIII, fig. 10.

Smaller, length 1.8, diam. 1 mm., and *quite distinctly striate.* Aperture about as in *columbiana*, but a little shorter.

Box Elder Cañon, Utah, elevation 4500 feet (Henry Hemphill).

Vertigo coloradensis (Cockerell).

Papa coloradensis Ckll., Journ. of Conch., Leeds, VI, 1889, p. 63 (name only); British Naturalist, 1891, p. 100 ;[19] and in Binney, Fourth Supplement to Terr. Moll., V, Bull. M. C. T., XXII. No. 4, p. 191 (January), 1892.

Vertigo coloradensis Ckll., Sterki, Nautilus, VI, 1892, p. 5. Cockerell, Nautilus, X, 1897, p. 134.

Papa coloradensis Ckll., Pilsbry, Nautilus, XI, 1898, p. 119; Classified Cat. L. Sh. Amer., p. 21.

"Shell brown, shiny, thinnish, translucent enough to show teeth through (body whorl) from outside, striate, especially on penultimate whorl. Outline oblong-oval, barrel-shaped, apex blunt. Whorls four. Aperture pyriform. Peristome brown, thick, continuous by a well-marked callus on parietal wall. Outer lip not constricted; a crest is indicated behind peristome, but not well developed. The teeth within the aperture are brown, one long one on parietal wall, one on columellar, and two, the lower one largest, on outer wall. Length $1\frac{1}{2}$, diam. 1 mm.

Fig. 2.

"Near Swift creek, Custer Co., Colo. (T. D. A. Cockerell).

[19] We have not seen Prof. Cockerell's paper in this journal, and do not know whether the species was described or merely mentioned there.

"This shell is nearest allied to *corpulenta*, but is decidedly smaller, more striate, and slightly narrower. I have never observed a second parietal tooth in *coloradensis*."

The above description, somewhat amplified from that published in Binney's Fourth Supplement, was received from Prof. Cockerell, and the figure was drawn by him. It seems to us more nearly related to *concinnula* than to *corpulenta*, on account of the long palatal folds; but the very small size distinguishes it, if constant. Only two or three specimens were taken, the type being in the British Museum.

V. coloradensis basidens n. var.

Similar to *V. c. arizonensis* P. & V., but the parietal lamella stands alone upon the parietal wall, and a small basal tubercle is developed. The last character separates *basidens* from typical *coloradensis*.

Bland, New Mexico (Rev. E. H. Ashman), with *V. c. arizonensis* and *V. concinnula*.

Vertigo coloradensis arizonensis n. var. Plate XXIII, fig. 9.

Shell cylindric-oval, rimate, very small; very densely and sharply but most minutely striate; light brown. Whorls $4\frac{3}{4}$, convex, the last tapering below, the later half whorl narrow as though pinched at base, flattened over the position of the palatal folds, then rising in a low, hardly noticeable crest, obsolete except near the base. Aperture irregularly truncate-oval, the peristome well expanded, brown. Denticles 5 or 6, the parietal high and strong, a minute angle lamella usually standing near its outer end. Columellar lamella obliquely entering. Upper and lower *palatal folds very long, rising conically in the middle*, distinctly showing through from the outside, the lower fold being a little stronger and more immersed, its position marked by a depression outside.

Length 1.8, diam. .9 mm.

Top of Mt. Mingus, near Jerome, Ariz., about 8,500 feet elevation (E. H. Ashmun).

This pygmy form differs from *V. columbiana* in being smaller, duller, more slender and with much longer palatal folds, which show their length well from the outside where they show through the outer wall. It is more slender and rather less coarsely striate than *V. columbiana utahensis*, besides differing in its long palatals.

V. concinnula differs chiefly in being very much larger, and *V. coloradensis* has only a single lamella on the parietal wall, and seems less cylindric.

Catalogue of Species and Subspecies of the United States.

Genus **PUPOIDES** Pfeiffer, 1855.

(*Leucocheila* Martens, 1860, of former lists.)

Group of P. marginatus.

Pupoides marginatus (Say).

Canada to Florida, west to Arizona.

This is *Pupa fallax* of authors, not of Say. See notes.

Pupoides modicus (Gld.).

Georgia sea islands and Florida, west to Alabama.

Group of P. chordatus.

Pupoides hordaceus (Gabb).

Arizona and New Mexico.

Genus **PUPA** Drap., 1801.

Group of P. muscorum.

Pupa hebes Ancey.

White Pine, Nev. (Newcomb); around Jerome, Ariz. (Ashmun).

Pupa muscorum (L.).

Canada and Northern States, southward in the Rocky Mountain region. Typical *muscorum* is toothless. Form *unidentata* C. Pfr., parietal tooth developed. Occurs with preceding. *P. badia* C. B. Ad. is a synonym. Form *bigranata* Rossm., a small, low lower palatal nodule also present. Occurs with preceding. Fig. of *muscorum* in Binney's works belongs to this last variety.

Pupa blandi Morse.

Rocky Mountain region. Form *obtusa* Ckll., Colorado.

Pupa blandi sublubrica Ancey.

Nevada.

Pupa sonorana Sterki.

New Mexico.

Pupa sonorana tenella Sterki.

Capitan Mountains, New Mexico.

Pupa syngenes Pilsbry.

New Mexico, Arizona, Montana.

Form *dextroversa* P. and V. (n. f.) is dextral, with 8½–9 whorls. San Rafael, N. M., collected by Rev. E. H. Ashmun.

Eighty-seven per cent. of the specimens taken at this locality were of the dextral form.

Group of P. sterkiana.

Pupa sterkiana Pilsbry.

San Diego county, Cal.; San Ramon, Lower Cal.

Genus **BIFIDARIA** Sterki, 1891.

Section IMMERSIDENS Pils. and Van., 1900.

Bifidaria ashmuni Sterki.

Arizona, Jerome; Santa Rita Mountains.

A form *minor* Sterki (*Nautilus*, XII, 92), Nogales, Ariz., is smaller, thinner, with narrower lip and 1 to ½ whorl less.

Bifidaria perversa Sterki.

Nogales, Ariz.

Section STERKIA Pilsbry, 1898.

Bifidaria rhoadsi Pilsbry.

Miami, Fla.

Bifidaria calamitosa (Pilsbry).

San Diego, Cal., to San Tomas river, Lower Cal.

Bifidaria hemphilli (Sterki).

Same range.

Bifidaria clementina (Sterki).

San Clemente Island.

Section PRIVATULA Sterki, 1893.

Bifidaria corticaria (Say).

Canada and Minnesota south to South Carolina and Mississippi.

Section BIFIDARIA s. str.

(*Eubifidaria* Sterki, 1893.)

Bifidaria dalliana Sterki.

Arizona.

Bifidaria hordeacella (Pilsbry)

Cape May, N. J., Georgia sea islands and Florida, west to Indian Territory and Arizona.

Bifidaria hordeacella parvidens Sterki.

Arizona.

Bifidaria rupicola (Say).

South Carolina and Florida, west to New Orleans, La., also Cuba, Bermuda.

Bifidaria procera (Gld.).

Maryland and South Carolina, west to Arizona and Mexico.

Bifidaria procera cristata Pils. and Van.

Arizona, New Mexico, Indian Territory and Texas.

Bifidaria quadridens Sterki.

Capitan Mountains, New Mexico.

Section ALBINULA Sterki, 1892.

Bifidaria contracta (Say).

Canada, United States and Mexico, east of Rocky Mountains.

Bifidaria armifera (Say).

Quebec and Maine to Minnesota, south to New Mexico and Florida. A var. *ruidosensis* Ckll. has been described from New Mexico.

Bifidaria holzingeri (Sterki).

Minnesota to Kansas and Illinois. A var. *fordiana* Sterki has been described from Wichita, Kan.

Subgenus **Vertigopsis** 'Ckll.' Sterki.

Nautilus, VI, p. 4, 101. Type *Pupa curvidens* Gld.

* Palatal folds two or three, in the typical positions; no palatal callous rib.

Bifidaria cincinnatiensis (Judge).

Cincinnati, O.

Bifidaria pilsbryana (Sterki).

Arizona and New Mexico.

** Palatal folds tuberculiform, their number increased by some accessory denticles, and standing upon a callous rib.

Bifidaria pentodon (Say).

Quebec to Alberta, south to Nevada, Texas and Florida; Sterki mentions a form *curta* from Ohio. *P. montanella* Ckll., undescribed, is a synonym.

Bifidaria curvidens (Gld.).

Quebec to Minnesota and southward.

Sterki distinguishes a form *gracilis* from Rhode Island, Ohio, Tennessee.

Bifidaria curvidens floridana (Dall).

Archer, Alachua county, Fla.

Genus **VERTIGO** Müller.

Section VERTIGO.

Vertigo rugosula Sterki.

South Carolina, Gulf coast to Texas.

Vertigo rugosula ovalis Sterki (**ovulum** Sterki, preoc.).

Volusia county, Fla.

Vertigo ovata Say.

Canada, United States and Mexico.

Pupa ovata antiquorum Ckll. is a synonym.

Vertigo morsei Sterki.

Kent county, Mich.; Sandusky, O.

Vertigo binneyana Sterki.

Manitoba to Seattle, Wash., south to New Mexico.

Vertigo pygmæa Drap.

Lake Superior and New England, south to Pennsylvania and west to Ohio. Synonyms: *V. callosa* Sterki, not Reuss; *P. superioris* Pilsbry.

Vertigo andrusiana Pilsbry.

Douglas county, Ore.

Vertigo arctica Wallenb.

Identified by Westerlund from Port Clarence, Alaska. We have not seen it.

Vertigo tridentata Wolf.

New York and eastern Pennsylvania to Illinois.

Vertigo parvula Sterki.

Northern Ohio; Mitchell county, N. C.

Vertigo ventricosa (Morse).

Quebec and Maine to Illinois. Synonym: *V. approximans* Sterki.

Vertigo ventricosa elatior Sterki.

Western Alberta to Ohio. Synonym: *V. gouldii lagganensis* Pilsbry.

Vertigo gould i Binn.

Ontario and Maine to Montana, south to Tennessee, Maryland and New Jersey. *V. gouldii paradoxa* Sterki is an undescribed variety from Woodland, Aroostook county, Me.

Vertigo gouldii bollesiana (Morse).

Middle and New England States.

Vertigo bollesiana arthuri Martens.

Little Missouri, Dakota. (Unknown to us.)

Vertigo columbiana Sterki.

Vancouver Island to Oregon.

Vertigo columbiana utahensis Sterki.

Box Elder Cañon, Utah.

Vertigo modesta (Say).

Synonym: *Pupa decora* Gld.

Lake Superior region to Alberta and northward; also loess of Iowa.

Vertigo modesta corpulenta (Morse).

Utah, Nevada.

Vertigo modesta parietalis (Anc.).

Utah and Colorado.

Vertigo modesta castanea (Sterki).

Fish Camp, Fresno county, and Lake County, Cal.

Vertigo coloradensis (Ckll.).

Custer county, Col.

Vertigo coloradensis basidens P. & V.

Bland, New Mexico.

Vertigo coloradensis arizonensis P. and V.

Jerome, Ariz.

Vertigo concinnula (Ckll.).

Colorado and New Mexico.

Vertigo rowelli (Newc.).

Oregon to middle portion of California.

Section NEARCTULA Sterki.

Vertigo californica (Rowell).

San Francisco, Cal.

Vertigo californica elongata Sterki.

San Clemente Island.

Vertigo californica catalinaria Sterki.

San Clemente Island and S. Catalina Island.

Vertigo californica diegoensis Sterki.

San Diego, Cal., to San Ramon, L. Cal.

Vertigo californica trinotata Sterki.

Monterey, Cal.

Vertigo californica cyclops Sterki.

Placer county, Cal.

Section HAPLOPUPA Pils.

Vertigo dalliana Sterki.

Lake county, Cal.

Section ———

Vertigo oscariana Sterki.

Florida to Texas; Tennessee.

Section BOTHRIOPUPA Pils.

Vertigo variolosa Gld.

Near mouth of Miami river, Fla.

Subgenus **Vertilla** Moq.-Tand.

Vertigo milium Gld.

Ontario and Maine, west to Minnesota, south to Florida and Texas.

EXPLANATION OF PLATES.

PLATE XXII.

Figures 9, 10, 11 × 13; 1–8 × 20.

Fig. 1. *Bifidaria rupicola* (Say). Tick Island, Volusia county, Fla. No. 69,500, coll. A. N. S.

Fig. 2. *B. hordeacella parvidens* Sterki. Mescal Gulch, Jerome, Ariz. No. 78,717.

Fig. 3. *B. hordeacella* (Pils.). New Braunfels, Tex. No. 60,460.

Figs. 4, 5. *B. procera cristata* Pils. and Van. Camp Verde. Ariz. No. 68,694.

Figs. 6, 7. *B. procera* (Gld.). Washington, D. C.

Fig. 8. *B. dalliana* Sterki. Nogales, Ariz. No. 78,689.

Figs. 9, 10. *Pupa hebes* Ancey. Summit of Mt. Mingus, near Jerome, Ariz. No. 78,709.

Fig. 11. *Pupoides hordaceus* (Gabb). Fort Grant, Ariz. One of the original lot, probably the type specimen.

PLATE XXIII.

All figures × 25.

Fig. 1. *Vertigo modesta parietalis* (Ancey). Ogden Cañon, Utah.

Fig. 2. *Vertigo modesta parietalis* (Anc.). Dyea Valley, Alaska. No. 73,661.

Fig. 3. *Vertigo modesta* (Say). Laggan, Alberta. No. 76,375.

Figs. 4, 5. *Vertigo modesta castanea* Sterki. Fish Camp, Fresno county, Cal.

Fig. 6. *Vertigo modesta* (Say). Labrador. No. 4,352.

Fig. 7. *Vertigo modesta corpulenta* (Morse). Ogden Cañon, Utah.

Fig. 8. *Vertigo concinnula* (Ckll.). Jemez Mountains, Ariz. No. 73,587.

Fig. 9. *Vertigo coloradensis arizonensis* Pils. and Van. Summit of Mt. Mingus, near Jerome, Ariz.

Fig. 10. *Vertigo columbiana utahensis* Sterki. Box Elder Cañon, Utah.

Fig. 11. *Vertigo columbiana* Sterki. Vancouver Island. No. 68,881.